CAPE CANAVERAL AIR FORCE STATION, LAUNCH COMPLEX 39, MOBILE LAUNCHER PLATFORMS
(John F. Kennedy Space Center)
Launcher Road, East of Kennedy Parkway North
Cape Canaveral
Brevard County
Florida

HAER FL-8-11-D
FL-8-11-D

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
SOUTHEAST REGIONAL OFFICE
National Park Service
U.S. Department of the Interior
100 Alabama St. NW
Atlanta, GA 30303

HISTORIC AMERICAN ENGINEERING RECORD

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Location: Launcher Road, east of Kennedy Parkway North
John F. Kennedy Space Center
Cape Canaveral
Brevard County
Florida

U.S.G.S. 7.5. minute Orsino, Florida, quadrangle,
Universal Transverse Mercator coordinates (Parking/Maintenance Site):
17.534073.3162655

Date of Construction: 1963-1968; 1976-1983 (modified for the Space Shuttle Program)

Architect: Reynolds, Smith and Hills, Jacksonville, Florida

Builder: Ingalls Iron Works (original); Conversions done by Blount Brothers Construction Company, Montgomery, Alabama; Algernon Blair Industrial Contractors, Inc., Norcross, Georgia; Belko Steel Corporation, Orlando; Industrial Steel Inc., Mims, Florida; Ivey's Steel Erectors, Inc., Merritt Island, and others.

Present Owner: National Aeronautics and Space Administration (NASA)
Kennedy Space Center, FL 32899-0001

Present Use: Aerospace Facility-vehicle integration and launching platform

Significance: The three Mobile Launcher Platforms (MLPs) are considered eligible for listing in the National Register of Historic Places (NRHP) in the context of the U.S. Space Shuttle Program (1969-2010) under Criteria A and C in the areas of Space Exploration and Engineering, respectively. The period of significance for the MLPs is from 1980, when the first flight-ready Space Shuttle vehicle (SSV) was assembled in the Vehicle Assembly Building (VAB) atop the MLP, through 2010, the designated end of the Space Shuttle Program. Because they have achieved significance within the past 50 years, Criteria Consideration G applies. Under Criterion A, the MLPs are significant for their unique function in supporting build-up of the SSV in the VAB and transport of the vehicle to the launch pad. Under Criterion C, the MLPs were specially designed, built and modified to support launch vehicles. The MLP provides a base for the vertical integration and stacking of the complete SSV, which is connected to the platform solely through the eight Solid Rocket Booster (SRB) hold-down posts. Each MLP is designed to carry the weight of a fueled shuttle, or 13.72 million pounds. Once complete, the SSV and MLP are rolled out to the launch pad on one of two Crawler Transporters. During launch, a series of explosions breaks the SRB connections, allowing the shuttle lift off from the platform.

Report Prepared by: Patricia Slovinac, Architectural Historian
Archaeological Consultants, Inc.
8110 Blaikie Court, Suite A
Sarasota, Florida 34240

Date: September 2009

HISTORICAL INFORMATION

NASA's John F. Kennedy Space Center

The John F. Kennedy Space Center (KSC) is the National Aeronautics and Space Administration's (NASA) primary Center for launch and landing operations, vehicle processing and assembly, and related programs in support of manned space missions. It is located on the east coast of Florida, about 150 miles south of Jacksonville, and to the north and west of Cape Canaveral, in Brevard and Volusia Counties, and encompasses almost 140,000 acres. The Atlantic Ocean and Cape Canaveral Air Force Station (CCAFS) are located to the east, and the Indian River is to the west.

Following the launch of Sputnik I and Sputnik II, which placed Soviet satellites into Earth's orbit in 1957, the attention of the American public turned to space exploration. President Dwight D. Eisenhower initially assigned responsibility for the U.S. Space Program to the Department of Defense (DoD). The Development Operations Division of the Army Ballistic Missile Agency (ABMA), led by Dr. Wernher von Braun, began to focus on the use of missiles to propel payloads, or even a man, into space. The United States successfully entered the space race with the launch of the Army's scientific satellite Explorer I on January 31, 1958 using a modified Jupiter missile named Juno I.[1]

With the realization that the military's involvement in the space program could jeopardize the use of space for peaceful purposes, President Eisenhower established NASA on October 1, 1958 as a civilian agency with the mission of carrying out scientific aeronautical and space exploration, both manned and unmanned. Initially working with NASA as part of a cooperative agreement, President Eisenhower officially transferred to NASA a large portion of the Army's Development Operations Division, including the group of scientists led by von Braun, and the Saturn rocket program.[2]

NASA became a resident of Cape Canaveral in 1958 when the Army Missile Firing Laboratory (MFL), then working on the Saturn rocket project under the direction of Kurt Debus, was transferred to the agency. Several Army facilities at CCAFS were given to NASA, including various offices and hangars, as well as Launch Complexes (LC) 5, 6, 26, and 34. The MFL was renamed Launch Operations Directorate (LOD) and became a branch office of Marshall Space Flight Center (MSFC). As LOD responsibilities grew, NASA granted the launch team increased status by making it a field center called the Launch Operations Center (LOC), and separating it from MSFC.

[1] Charles D. Benson and William B. Faherty. *Gateway to the Moon. Building the Kennedy Space Center Launch Complex*. (Gainesville, University Press of Florida, 2001), 1-2.
[2] Benson and Faherty, 15.

In May 1961, President John F. Kennedy charged NASA and the associated industries to develop a space program that would surpass the Soviet program by landing a man on the Moon by the end of the decade. With the new, more powerful Saturn V rocket and the stepped-up launch schedule, it was apparent that a new launch complex was required, and CCAFS, with twenty-two launch complexes, did not have the space for new rocket facilities. Merritt Island, an undeveloped area west and north of the Cape, was selected for acquisition, and in 1961 the Merritt Island Launch Area (MILA, which, with the LOC, would become KSC) was born. In that year, NASA requested from Congress authority to purchase 80,000 acres of property, which was formally granted in 1962. The U.S. Army Corps of Engineers (ACOE) acted as agent for purchasing the land, which took place between 1962 and 1964. NASA began gaining title to the land in late 1962, taking over 83,903.9 acres by outright purchase, which included several small towns, such as Orsino, Wilson, Heath and Audubon, many farms, citrus groves, and several fish camps. Negotiations with the State of Florida provided submerged lands, resulting in the acquisition of property identified on the original Deed of Dedication. Much of the State-provided land was located south of the Old Haulover Canal and north of the Barge Canal.

The American program to put a man in space and land on the Moon proceeded rapidly with widespread support. In November 1963, the LOC and MILA were renamed John F. Kennedy Space Center to honor the late President.[3] The space program was organized into three phases: Projects Mercury, Gemini, and Apollo. Project Mercury, initiated in 1958, was executed in less than five years. Begun in 1964, Project Gemini was the intermediate step toward achieving a manned lunar landing, bridging the gap between the short-duration Mercury flights and the long-duration missions proposed for the Apollo Program.[4]

Apollo, the largest and most ambitious of the manned space programs, had as its goal the landing of astronauts on the Moon and their safe return to Earth. Providing the muscle to launch the spacecraft was the Saturn family of heavy vehicles. Saturn IB rockets were used to launch the early unmanned Apollo test flights and the first manned flight, Apollo 7, which carried astronauts on a ten-day earth orbital mission.[5]

Three different launch vehicles were used in Apollo: Saturn I, Saturn IB and Saturn V; and three different launch complexes were involved: LC 34 and LC 37 on CCAFS, and LC 39 on KSC (only LC 39 is still active). Altogether, thirty-two Saturn flights occurred (seven from LC 34, eight from LC 37, and seventeen from LC 39, including Skylab and the Apollo-Soyuz Test Project) during the Apollo era. Of the total thirty-two, fifteen were manned, and of the seven attempted lunar landing missions, six were successful. No major launch vehicle failures of either

[3] Harry A Butowsky. *Reconnaissance Survey: Man in Space*. (Washington, D.C.: National Park Service, 1981), 5; Benson and Faherty, 146.
[4] Butowsky, 5.
[5] Butowsky, 5.

Saturn IB or Saturn V occurred. There were two major command/service module (CSM) failures, one on the ground (Apollo 1) and one on the way to the Moon (Apollo 13).[6]

The unmanned Apollo 4 mission, which lifted off on November 9, 1967, was the first Saturn V launch and the first launch from LC 39 at KSC. On July 21, 1969, the goal of landing a man on the Moon was achieved when Apollo 11 astronauts Armstrong, Aldrin, and Collins successfully executed history's first lunar landing. Armstrong and Aldrin walked on the surface of the Moon for twenty-two hours and collected 21 kilograms of lunar material. Apollo 17 served as the first night launch in December 1972. An estimated 500,000 people saw the liftoff, which was the final launch of the Apollo Program.[7]

Skylab, an application of the Apollo Program, served as an early type of space station. With 12,700 cubic feet of work and living space, it was the largest habitable structure ever placed in orbit, at the time. The station achieved several objectives: scientific investigations in Earth orbit (astronomical, space physics, and biological experiments); applications in Earth orbit (earth resources surveys); and long-duration spaceflight. Skylab 1 orbital workshop was inhabited in succession by three crews launched in modified Apollo CSMs (Skylab 2, 3 and 4). Actively used until February 1974, Skylab 1 remained in orbit until July 11, 1979, when it re-entered Earth's atmosphere over the Indian Ocean and Western Australia after completing 34,181 orbits.[8]

The Apollo-Soyuz Test Project (ASTP) of July 1975, the final application of the Apollo Program, marked the first international rendezvous and docking in space, and was the first major cooperation between the only two nations engaged in manned space flight. As the first meeting of two manned spacecraft of different nations in space, first docking, and first visits by astronauts and cosmonauts into the others' spacecraft, the ASTP was highly significant. The ASTP established workable joint docking mechanisms, taking the first steps toward mutual rescue capability of both Russian and American manned missions in space.[9]

On January 5, 1972, President Nixon delivered a speech in which he outlined the end of the Apollo era and the future of a reusable space flight vehicle, the Space Shuttle, which would provide "routine access to space." By commencing work at this time, Nixon added, "we can have the Shuttle in manned flight by 1978, and operational a short time after that".[10] The Space Task Group (STG), previously established by President Nixon in February 1969 to recommend a future course for the U.S. Space Program, presented three choices of long-range space plans. All included an Earth–orbiting space station, a space shuttle, and a manned Mars expedition.[11]

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[6] NASA. *Facts: John F. Kennedy Space Center.* (1994), 82.
[7] NASA. *Facts*, 86-90.
[8] NASA. *Facts*, 91.
[9] NASA. *Facts*, 96.
[10] Marcus Lindroos. "President Nixon's 1972 Announcement on the Space Shuttle." (NASA Office of Policy and Plans, NASA History Office, updated 14 April 2000).
[11] NASA, History Office, NASA Headquarters. "Report of the Space Task Group, 1969."

Although none of the original programs presented was eventually selected, NASA implemented a program, shaped by the politics and economic realities of its time, that served as a first step toward any future plans for implementing a space station.[12]

During this speech, President Nixon instructed NASA to proceed with the design and building of a partially reusable space shuttle consisting of a reusable orbiter, three reusable main engines, two reusable solid rocket boosters (SRBs), and one non-reusable external liquid fuel tank (ET). NASA's administrators vowed that the shuttle would fly at least fifty times a year, making space travel economical and safe. NASA gave responsibility for developing the shuttle orbiter vehicle and overall management of the Space Shuttle Program (SSP) to the Manned Spacecraft Center (MSC; now Johnson Space Center [JSC]) in Houston, based on the Center's experience. MSFC in Huntsville, Alabama was responsible for development of the Space Shuttle Main Engine (SSME), the SRBs, the ET, and for all propulsion-related tasks. Engineering design support continued at MSC, MSFC and NASA's Langley Research Center (LaRC), in Virginia, and engine tests were to be performed at NASA's National Space Technology Laboratories (NSTL, later named Stennis Space Center [SSC]) in Mississippi, and at the Air Force's Rocket Propulsion Laboratory in California, which later became the Santa Susana Field Laboratory (SSFL).[13] NASA selected KSC as the primary launch and landing site for the SSP. KSC, responsible for designing the launch and recovery facilities, was to develop methods for shuttle assembly, checkout, and launch operations.[14]

On September 17, 1976, the full-scale Orbiter Vehicle (OV) prototype *Enterprise* (OV- 101) was completed. Designed for test purposes only and never intended for space flight, structural assembly of this orbiter had started more than two years earlier in June 1974 at Air Force Plant (AFP) 42 in Palmdale, California. Although the *Enterprise* was an aluminum shell prototype incapable of space flight, it reflected the overall design of the orbiter. As such, it served successfully in 1977 as the test article during the Approach and Landing Tests (ALT) aimed at checking out both the mating with the Boeing 747 Shuttle Carrier Aircraft (SCA) for ferry operations, as well as the orbiter's unpowered landing capabilities.

The first orbiter intended for space flight, *Columbia* (OV-102), arrived at KSC from AFP 42 in March 1979. Originally scheduled to lift off in late 1979, the launch date was delayed by problems with both the SSME components as well as the thermal protection system (TPS). *Columbia* spent 610 days in the Orbiter Processing Facility (OPF), another thirty-five days in the

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12 Dennis R. Jenkins. *Space Shuttle, The History of the National Space Transportation System. The First 100 Missions*. (Cape Canaveral, Florida: Specialty Press, 2001), 99.

13 Jenkins, 122.

14 Linda Neuman Ezell. *NASA Historical Databook Volume III Programs and Projects 1969-1978*. The NASA History Series, NASA SP-4012, (Washington, D.C.: NASA History Office, 1988), Table 2-57; Ray A. Williamson. "Developing the Space Shuttle." *Exploring the Unknown: Selected Documents in the History of the U.S. Civil Space Program, Volume IV: Accessing Space*. (Edited by John M. Logsdon. Washington, D.C.: U.S. Printing Office, 1999), 172-174.

Vehicle Assembly Building (VAB) and 105 days on Launch Pad 39A before finally lifting off on April 12, 1981. STS-1, the first orbital test flight and first Space Shuttle Program mission, ended with a landing on April 14 at Edwards Air Force Base (AFB) in California. This launch demonstrated *Columbia's* ability to fly into orbit, conduct on-orbit operations, and return safely.[15] *Columbia* flew three additional test flights in 1981 and 1982, all with a crew of two. The Orbital Test Flight Program ended in July 1982 with 95 percent of its objectives completed. After the end of the fourth mission, President Ronald Reagan declared that with the next flight the Shuttle would be "fully operational."

A total of 124 Space Shuttle missions have been launched from the KSC between April 1981 and January 2009. From April 1981 until the *Challenger* accident in January 1986, between two and nine missions were flown yearly, with an average of four to five per year. The milestone year was 1985, when nine flights were successfully completed. The years between 1992 and 1997 were the most productive, with seven or eight yearly missions. Since 1995, in addition to its unique responsibility as the shuttle launch site, KSC also became the preferred landing site.

Over the past two decades, the SSP has launched a number of planetary and astronomy missions including the Hubble Space Telescope (HST), the Galileo probe to Jupiter, Magellan to Venus, and the Upper Atmospheric Research Satellite. In addition to astronomy and military satellites, a series of Spacelab research missions were flown, which carried dozens of international experiments in disciplines ranging from materials science to plant biology. Spacelab was a manned, reusable, microgravity laboratory flown into space in the rear of the Space Shuttle cargo bay. It was developed on a modular basis allowing assembly in a dozen arrangements depending on the specific mission requirements.[16] The first Spacelab mission, carried aboard *Columbia* (STS-9), began on November 28, 1983. Four Spacelab missions were flown between 1983 and 1985. Following a hiatus in the aftermath of the *Challenger* disaster, the next Spacelab mission was not launched until 1990. In total, twenty-four Space Shuttle missions carried Spacelab hardware before the program was decommissioned in 1998.[17] In addition to astronomical, atmospheric, microgravity, and life sciences missions, Spacelab was also used as a supply carrier to the HST and the Soviet space station *Mir*.

In 1995, a joint U.S./Russian Shuttle-*Mir* Program was initiated as a precursor to construction of the International Space Station (ISS). *Mir* was launched in February 1986 and remained in orbit until March 2001.[18] The first approach and flyaround of *Mir* took place on February 3, 1995 (STS-63); the first *Mir* docking was in June 1995 (STS-71). During the three-year Shuttle-*Mir*

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[15] Jenkins, 268.
[16] NASA. *NASA Shuttle Reference Manual.* (1988).
[17] STS-90, which landed on 3 May 1998, was the final Spacelab mission. NASA KSC. "Shuttle Payloads and Related Information." KSC Factoids. Revised 18 November 2002.
[18] Tony Reichhardt (editor). *Space Shuttle, The First 20 Years.* (Washington, D.C.: Smithsonian Institution, 2002), 85.

Program (June 27, 1995 to June 2, 1998) the Space Shuttle docked with *Mir* nine times. All but the last two of these docking missions used the Orbiter *Atlantis*. In 1995, Dr. Norman Thagard was the first American to live aboard the Russian space station. Over the next three years, six more U.S. astronauts served tours on *Mir*. The Shuttle served as a means of transporting supplies, equipment and water to the space station in addition to performing a variety of other mission tasks, many of which involved earth science experiments. It returned to Earth experiment results and unneeded equipment. The Shuttle-*Mir* program served to acclimate the astronauts to living and working in space. Many of the activities carried out were types they would perform on the ISS.[19]

On December 4, 1999, *Endeavour* (STS-88) launched the first component of the ISS into orbit. As noted by Williamson, this event marked, "at long last the start of the Shuttle's use for which it was primarily designed – transport to and from a permanently inhabited orbital space station."[20] STS-96, launched on May 27, 1999, marked the first mission to dock with the ISS. Since that time, most Space Shuttle missions have supported the continued assembly of the space station. As currently planned, ISS assembly missions will continue through the life of the Space Shuttle Program.

The SSP suffered two major setbacks with the tragic losses of the *Challenger* and *Columbia* on January 28, 1986 and February 1, 2003, respectively. Following the *Challenger* accident, the SSP was suspended, and President Ronald Reagan formed a thirteen-member commission to identify the cause of the disaster. The Rogers Commission report, issued on June 6, 1986, which also included a review of the SSP, concluded "that the drive to declare the Shuttle operational had put enormous pressures on the system and stretched its resources to the limit".[21] In addition to mechanical failure, the Commission noted a number of NASA management failures that contributed to the catastrophe. As a result, among the tangible actions taken were extensive redesign of the SRBs; upgrading of the Space Shuttle tires, brakes, and nose wheel steering mechanisms; the addition of a drag chute to help reduce speed upon landing; the addition of a crew escape system; and the requirement for astronauts to wear pressurized flight safety suits during launch and landing operations. Other changes involved reorganization and decentralization of the SSP. NASA moved the management of the program from JSC to NASA Headquarters, with the aim of preventing communication deficiencies.[22] Experienced astronauts were placed in key NASA management positions, all documented waivers to existing flight safety criteria were revoked and forbidden, and a policy of open reviews was implemented.[23] In addition, NASA adopted a Space Shuttle flight schedule with a reduced average number of launches, and discontinued the long-term practice of launching commercial and military

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[19] Judy A. Rumerman, with Stephen J. Garber. *Chronology of Space Shuttle Flights 1981-2000*. HHR-70. (Washington, D.C.: NASA History Division, Office of Policy and Plans, October 2000), 3.
[20] Williamson, 191.
[21] Columbia Accident Investigation Board (CAIB). *Report Volume I*. (August 2003), 25.
[22] CAIB, 101.
[23] Cliff Lethbridge. "History of the Space Shuttle Program." (2001), 4.

payloads.[24] The launch of *Discovery* (STS-26) from KSC Pad 39B on September 29, 1988 marked a Return to Flight after a thirty-two-month hiatus in manned spaceflight following the *Challenger* accident.

In the aftermath of the 2003 *Columbia* accident, a seven month investigation ensued, concluding with the findings of the Columbia Accident Investigation Board (CAIB), which determined that both technical and management conditions accounted for the loss of the orbiter and crew. According to the CAIB Report, the physical cause of the accident was a breach in the TPS on the leading edge of the left wing, caused by a piece of insulating foam, which separated from the ET after launch and struck the wing.[25] NASA spent more than two years researching and implementing safety improvements for the orbiters, SRBs and ET. Following a two-year hiatus, the launch of STS-114 on July 26, 2005 marked the first Return to Flight since the loss of *Columbia.*

On January 14, 2004, President George W. Bush outlined a new space exploration initiative in a speech given at NASA Headquarters.

> *Today I announce a new plan to explore space and extend a human presence across our solar system . . . Our first goal is to complete the International Space Station by 2010 . . . The Shuttle's chief purpose over the next several years will be to help finish assembly of the International Space Station. In 2010, the Space Shuttle – after nearly 30 years of duty – will be retired from service. . . Our second goal is to develop and test a new spacecraft, the Crew Exploration Vehicle, by 2008, and to conduct the first manned mission no later than 2014. . . Our third goal is to return to the Moon by 2020, as the launching point for missions beyond ...*[26]

Following the President's speech, NASA released *The Vision for Space Exploration*, which outlined the Agency's approach to the new direction in space exploration.[27] In 2006, NASA announced the start of the Constellation Program, which included development of the Crew Exploration Vehicle (CEV) and a launch vehicle to place the CEV into space. As part of this initiative, NASA will continue to use the Space Shuttle to complete assembly of the ISS. The Shuttle will not be upgraded to serve beyond 2010 and, after completing the ISS, the Space Shuttle Program will be retired. The next generation of human-rated spacecraft, the CEV, named *Orion*, will transport humans to low Earth orbit for missions to support the ISS, and will also be the vehicle used to carry a crew to lunar orbit. The Constellation Program will develop the new

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[24] Lethbridge, 5.
[25] CAIB, 9.
[26] The White House. "A Renewed Spirit of Discovery – The President's Vision for Space Exploration." (January 2004).
[27] NASA Headquarters. "The Vision for Space Exploration." (February 2004).

class of exploration vehicles to launch both crew and cargo and associated infrastructure in exploring the Moon, Mars, and beyond.

Development of KSC's LC 39 and VAB Areas

Today, KSC maintains operational control over 3,800 acres, all located in Brevard County. The major facilities are located within the Industrial Area, the LC 39 Area, the VAB Area, and the Shuttle Landing Facility (SLF) Area. The LC 39 and VAB Areas were developed primarily to support launch vehicle operations and related launch processing activities. They contain the VAB, the Launch Control Center (LCC), the Orbiter Processing Facilities (OPF), the two Launch Pads, A and B, and other support facilities.

Following completion of the Apollo-Soyuz Test Project in 1975, the facilities of KSC were modified to support the Space Shuttle Program. KSC was originally one of three possible launch sites evaluated, along with Vandenberg AFB in California and the White Sands Missile Range in New Mexico. Compared with the other two locations, KSC had the advantage of approximately $1 billion in existing launch facilities. Thus, less time and money would be needed to modify existing facilities at KSC rather than to build new ones at another location. The estimates of $200 to $400 million to modify the existing KSC facilities was roughly half the cost of new construction. In addition, only KSC had abort options for a first revolution return of the low cross-range orbiter.[28]

To help keep costs down, beginning ca. 1976, KSC engineers adapted and modified many of the Apollo launch facilities to serve the needs of the SSP. Among the key facilities undergoing change were the VAB, the LCC, and LC 39 Pads A and B. New facilities were constructed only when a unique requirement existed. The major new structures included the SLF and the OPFs. Multi-million dollar contracts for design and construction were awarded to both national and local firms, including Reynolds, Smith and Hills (RS&H) of Jacksonville, Florida; the Frank Briscoe Company, Inc. of East Orange, New Jersey; Algernon Blair Industrial Contractors, Inc. of Norcross, Georgia; the Holloway Corporation of Titusville, Florida; and W&J Construction Corporation of Cocoa, Florida.

Alterations to the VAB included modification of two of the four high bays for assembly of the Space Shuttle vehicle, and changes to the other two high bays to accommodate the processing and stacking of the SRBs and ET. The north doors were widened by almost 40' to permit entry of the towed orbiter. Work platforms shaped to fit the shuttle configuration were added to High Bays 1 and 3 where shuttle assembly takes place, and internal structural changes were also made to High Bays 2 and 4, where the ETs are processed.

[28] Jenkins, 112.

Major changes were made to LC 39, Pads A and B. Modifications were completed in mid-1978 at Pad A and in 1985 at Pad B. With the exception of the six fixed pedestals which support the Mobile Launcher Platform (MLP), all of the structures on the hardstands of each pad were removed or relocated. Fuel, oxidizer, high-pressure gas, electrical, and other service lines were rerouted. New hypergolic fuel and oxidizer support areas were constructed at the southwest and southeast corners, respectively, of the pads; the unneeded Saturn fuel support area was removed, a new Fixed Service Structure (FSS) was erected using an original Apollo-era Launch Umbilical Tower (LUT), a Rotating Service Structure (RSS) was added, the Saturn flame deflectors were replaced, and a Payload Changeout Room (PCR) and Payload Ground Handling Mechanism (PGHM) were added. A sound suppression water system was installed on the pads to reduce the acoustical levels within the orbiter's payload and thus, to protect it and its payloads from damage. A related system, the Overpressure Suppression System, was installed to reduce the pressure pulse at SRB ignition.[29]

Additional changes were made to Pad A and Pad B in the aftermath of the 1986 *Challenger* accident; other modifications followed the Return to Flight in 1988. Among the modifications were the installation of new weather protection structures to supplement the RSS; improvements in temperature and humidity controls for the PCR; upgrades to the emergency exit system, including the addition of two slidewire baskets; installation of new elevators on the RSS; and improvements to the pad communications system. Changes were first made at Pad B, followed by identical changes at Pad A.

Mobile Launcher Platforms

The three MLPs were originally constructed for the Apollo Program (Figure No. A-1). Known simply as the mobile launchers (ML), they consisted of a two-story platform with four hold-down posts (what would become the MLP), and a LUT with a hammerhead crane mounted to the top and nine service arms attached to the side. The platform and tower were designed by RS&H; the service arms were designed by Brown Engineering Company of Huntsville, Alabama.[30] Construction of ML-1 by Ingalls Iron Works of Birmingham, Alabama, was begun in July 1963. Mechanical and electrical systems installation, by Smith-Ernst of New York City, proceeded concurrently. By March 1965, the structural steel framework for all three MLs was completed, and beginning in June of that year, the Pacific Crane and Rigging Company began installation of ground support equipment. The three MLs were in service by the fall of 1968. Through the Apollo, Skylab, and Apollo-Soyuz Programs, ML-1 supported seven launches; and ML-2 and ML-3 supported five launches each.[31]

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[29] Wallace H. Boggs and Samuel T. Beddingfield. "Moonport to Spaceport. The Changing Face at KSC." *Astronautics & Aeronautics,* July-August 1982, 28-41.
[30] The arms were built by Hayes International, of Birmingham, Alabama. Benson & Faherty, 283.
[31] Benson & Faherty, 279-284; NASA KSC. *Kennedy Space Center Story.* (KSC), 1972, 27-29.

With the advent of the Space Shuttle Program, the three MLs were modified extensively for use with the new vehicle. In 1975, Reynolds, Smith & Hill created drawings for the conversion of ML-3 into the first "mobile launcher platform," MLP-1.[32] In September of that year, Blount Brothers Construction Company of Montgomery, Alabama received the contract to perform the modifications; work was to be completed in 547 days (Figure Nos. A-2 through A-4).[33] Fabrication and assembly of the platform's two tail service masts (TSM) was done by Belko Steel Corporation of Orlando, Florida.[34] In September 1976, RS&H received a second design contract for the conversion of ML-2 into MLP-2, and in July 1977, a $7.3 million contract was awarded to Algernon Blair Industrial Contractors, Inc. to execute the work.[35] Industrial Steel Inc., of Mims, Florida, fabricated and assembled the two TSMs for this platform.[36] Finally, in November 1982, RS&H was awarded an extension to their current contract for the drawings to convert ML-1 into MLP-3; a Detroit, Michigan, firm was hired to complete the work, which was finished in 1989.[37]

The most obvious visual difference between the MLs and the MLPs was the removal of the LUT and its service arms and hammerhead crane. Instead, a permanent service structure was built at each launch pad.[38] Because the LUT's service arms provided all umbilicals to the Apollo vehicle, the removal of the tower prompted the use of two large TSMs to provide all of the umbilical connections to the Space Shuttle vehicle. In conjunction with the new masts, the elevation of "Side 1" of the platforms would change drastically. While that of the ML had no features other than a few pipe connections, the liquid oxygen (LOX) and liquid hydrogen (LH2) valves for the new platform's umbilicals would be positioned here among an assembly of platforms.[39]

Another major alteration to the platforms was the replacement of the single exhaust opening with three exhaust openings, one for the orbiter's SSMEs and one for each of the two SRBs. Accordingly, the Saturn V hold-down posts within the ML's opening were also removed; however, the same technique was employed on the new platform. Each of the new SRB openings was fitted with four hold-down posts, sized appropriately for the thinner boosters. Additionally, with the new layout of exhaust openings and the removal of the LUT, a new layout of blast

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[32] RS&H. "Modifications to convert ML No. 3 to Mobile Launcher Platform No. 1/MLP No. 1." March 1975.
[33] "KSC Starts Pad 39 Mods for Space Shuttle Launches." *Roundup* (14, 20), 26 September 1975: 4.
[34] Frank E. Jarrett. "Chronology of KSC and KSC Related Events for 1977." KHR-3, 1 November 1978, 40.
[35] Frank E. Jarrett. "Chronology of KSC and KSC Related Events for 1976." KHR-2, 1 November 1977, 40; "Chronology for 1977," 49.
[36] Ken Nail, Jr. and Elaine Liston. "Chronology of KSC and KSC Related Events for 1980." No date, 99.
[37] Ken Nail, Jr. and Elaine Liston. "Chronology of KSC and KSC Related Events for 1982." 1 March 1984, 265; "Mobile Launcher to be Modified." *Space News Roundup* (22, 6), 25 March 1983: 2; Ken Nail, Jr. and Elaine Liston. "Chronology of KSC and KSC Related Events for 1989." KHR-14, 1 March 1990, 101. None of the sources used provided the name of the Detroit company.
[38] See page 11.
[39] RS&H, 1975, Sheets A5 and A15. Also see Photos 9 and 10.

shields was required. Therefore, the Apollo-era blast shields were removed, and new ones were constructed, including the 96' x 64' blast deck where the LUT once stood. Because the orbiter and its payloads would be closer to the surface of the platform than its predecessor was, severe damage from the acoustical energy produced at launch was possible. Thus, a water-based sound suppression system was designed for the platform. Finally, the platforms various mechanical, electrical, and communications systems were upgraded to support the new vehicle's technology.[40]

Since their initial conversion from mobile launchers to mobile launcher platforms, the three MLPs have undergone further modifications, mostly with regard to the various systems. Following the *Challenger* accident, external heaters were added to the SRB field joints to maintain the desired temperature on the joints and igniters until lift-off. In conjunction, an umbilical was installed, which aided in providing power, instrumentation, and controls to the heaters. In addition, changes were made to the gaseous nitrogen (GN2) feed system, which increased the temperature of the gas to help warm the seals.[41] In 1990, each MLP received three new batteries to provide back-up power to the orbiter at the launch pad, in case of a power outage; and between 2000 and 2001, the hazardous gas detection system was replaced with a more modern system that uses redundant components as opposed to a back-up system. This new system greatly reduced the risk of a false positive reading, which generally led to a costly cancellation of the launch.[42] In 2004, new valves were installed on each MLP for the sound suppression system, which were then tested at the launch pad (Figure No. A-8).[43] More recently, MLP-2 and MLP-3 received a new electrical substation and new orbiter interfaces. These were not installed on MLP-1, which will be retrofitted for the new Ares I rocket.[44]

MLP Functions and Capabilities

The MLP is two-story steel structure that serves as a transportable launch base. As a platform, it supports vehicle mating activities; maintains the vehicle in a launch attitude during check-out, transfer to the launch pad, and while waiting at the pad for lift-off; provides structural support during thrust build-up sequences; and provides access to the aft end of the vehicle for servicing and check-out. As a launch base, the MLP routes all necessary ground servicing, checkout and

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[40] NASA KSC. "Sound Suppression Water System." Countdown! NASA Launch Vehicles and Facilities. October 1991; NASA KSC. *Space Shuttle Launch Support Equipment Data Handbook*, Engineering Development Directorate, KSC-DD-186 Revision A, 30 March 1993, Section XIX.

[41] NASA KSC "Shuttle Facilities: New Structures and Modifications." NASA Facts. Release No. 10-89, February 1989.

[42] "Haz Gas System set for STS-109: NASA, USA, Dynacs team on safety upgrade." *Spaceport News* (41, 3), 8 February 2002: 1 and 7.

[43] Jeff Stuckey. "Launch pad sound suppression test greeted with cheers." *Spaceport News* (43, 11) 21 May 2002: 4.

[44] Brett Raulerson. Interview with Patricia Slovinac, KSC, Vehicle Assembly Building, 17 October 2008.

control systems between the shuttle and the VAB or the shuttle and the launch pad. The MLP can also serve as a test stand for flight readiness firing engine tests.[45]

The MLP is stored either within High Bays 1 or 3 of the VAB, or at the MLP maintenance and parking site, located to the north of the VAB. Regardless of its location, the MLP rests on six pedestals, which are permanent to the site as opposed to fixtures on the platform. While not in use, the MLP is undergoing maintenance by the Mobile Launcher Operations division of United Space Alliance. This includes an examination of all systems within the MLP, replacement of any electrical/mechanical components (such as circuit breakers), as well as platform cleaning procedures.[46]

In preparation for shuttle stacking and processing, the MLP is taken into the high bay of the VAB where the vehicle will be assembled. Once the MLP is in place, the eight SRB hold down posts (four per side) are optically aligned. Once the platform is ready, either the starboard or port SRB aft motor is brought into the VAB and placed on its respective hold down posts, where it is attached to the top and bottom of a 28'-long, 3.5"-diameter stud with pyrotechnic bolts. Then, the other SRB aft motor is brought in and the same process carried out.[47] From there, the remaining SRB segments, the ET, and the orbiter are all mated to one another atop the MLP. Once all stacking procedures are finished, verification tests are performed on all system umbilicals and interfaces, and the entire assembly is taken to the launch pad by the Crawler Transporter.

Upon arrival at the launch pad, the MLP is aligned and attached to the six standard support pedestals, as well as four additional supports, which help to stiffen the platform against rebound loads in the case of main engine cutoff. Then, all electrical and mechanical umbilicals and interfaces between the launch pad and the Space Shuttle are connected through the platform, and a launch pad validation process is conducted.[48] Once all of this is completed, preparations can begin for loading propellants into both the orbiter and the ET.

All propellants that are loaded onto the vehicle at the launch pad pass through the two TSMs. These masts contain the fluid, gas, and electrical umbilicals for the orbiter's LOX and LH2 supply; LOX through the starboard TSM; LH2 through the port TSM. At different stages during launch preparation and countdown, these lines feed propellants to the two orbital maneuvering system (OMS) pods, the forward reaction control system (FRCS), various orbiter fuel cells, and

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[45] *Equipment Data Handbook*, Section XIX.

[46] Raulerson.

[47] These eight SRB hold down posts are the only places where the Space Shuttle vehicle is connected to the MLP. Ron Tucker. Interview with Patricia Slovinac, KSC, Vehicle Assembly Building, 13 May 2008; NASA "NASA Centers and Responsibilities." *NSTS 1988 News Reference Manual.* 1988.

[48] "NASA Centers and Responsibilities"; Elaine Liston. "Chronology of KSC and KSC Related Events for 2007." February 2008, p 81-110.

the ET.[49] Additionally, the TSMs provide umbilicals for various gases, including gaseous hydrogen (GH2), gaseous oxygen (GO2), gaseous helium (GHe), and GN2; connections for ground and flight coolants; lines for electrical power and purge air; and links for ground-to-vehicle data and communications.[50]

During the shuttle launch sequence, systems within the MLP have specific functions to perform. Ten seconds prior to SSME ignition, the Hydrogen Burnoff System, located within the TSMs, engages. This system eliminates any hydrogen molecules floating around the engines to prevent an explosion at launch.[51] At sixteen seconds prior to ignition, the sound suppression water system initializes from the water tower to the northeast of the launch pad. The water runs through large pipes from the tower to the MLP, which it reaches just prior to lift-off flowing at a rate of 900,000 gallons per minute. The water travels through large pipes throughout the internal levels of the platform, and emerges on the surface through six "rainbirds"[52] at the north end of the platform, sixteen nozzles mounted on the pad's flame deflectors, and various outlets in the SSME exhaust hole (See Figure No. A-8). This water blankets the surfaces of the MLP to absorb the acoustical pressures and prevent damage to the orbiter and its payloads. Additionally, large bags suspended from knobs around the SRB exhaust holes contain water to further aid in shock suppression.[53]

The platform itself also has two functions to perform at liftoff. The first of these occurs within the two SRB exhaust holes. At SRB ignition, the pyrotechnic bolts that attach the boosters to their hold-down posts explode. With this explosion, the stud to which the SRB is mounted is forced downward into a deceleration stand, and the pieces of the bolt assembly are captured within a spherical debris catcher at the top of the hold-down post. These actions prevent the stud and the bolt pieces from flying loose and causing damage to the vehicle. Finally, at lift-off, additional explosives are fired in each of the two TSMs. These blasts release an approximately 15,000 pound counterweight, which pulls all of the umbilicals into their respective mast, and rotates each mast's hood closed to protect the connections from any damage caused by the SSME exhaust.[54]

Once the Space Shuttle has successfully launched, the MLP is left in place at the pad to cool, and is then washed down to remove any chemicals from the vehicle's propellants. Afterwards, all

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[49] "NASA Centers and Responsibilities"; "Chronology for 2007," p 81-110.

[50] "NASA Centers and Responsibilities"; NASA, *Countdown! NASA Space Shuttles and Facilities.* Information Summary IS-2005-06-017-KSC (KSC), June 2005.

[51] "Launch Complex 39, Pads A and B." NASA Facts FS-2004-07-012-KSC, July 2004, rev. 2006; "Sound Suppression Water System."

[52] See page 18.

[53] The sound suppression water can also be used to cool the aft end of the orbiter in case of a pad abort. "Launch Complex 39, Pads A and B;" "Sound Suppression Water System;" Raulerson.

[54] "Launch Complex 39, Pads A and B;" "Sound Suppression Water System;" Raulerson.

umbilicals and interfaces are disconnected from the launch pad, and the MLP is transported back to the VAB or the maintenance site by the Crawler.

Physical Description[55]

Exterior

MLP-3 measures approximately 160' in length, 135' in width, and 25' in height overall, excluding the support pedestals. It is comprised of a structural steel skeleton faced with insulated metal sheeting. In plan, MLP-3 has three exhaust holes, one for each of the two SRBs, and one for the SSMEs. These openings extend through the entire height of the platform. In section, MLP-3 contains three levels: the "0 Level," or the top of the platform; the "A Level," or the middle level; and the "B Level," or the lower level. The sides of the MLP are numbered 1 through 4. Side 1 and "Side 3" are the shorter sides and correspond to the top and bottom of the Space Shuttle vehicle, respectively, when it is assembled on the platform; "Side 2" and "Side 4" are the longer sides and correlate to the port and starboard sides of the shuttle, respectively. At the launch pad, Side 1 is the south elevation of the MLP; Side 2 is the west; Side 3 is the north; and Side 4 is the east.[56]

Side 1 has a height of 22', and of the four elevations, contains the most equipment (Photo Nos. 1, 2, and 8). At each end of the bottom surface is a triangular bracket that extends down to the support pedestals, No. 6 at the west and No. 3 at the east. Also at these corners is a caged emergency egress ladder, which leads to the support pedestal. Other general features of Side 1 include an access door to the B Level, and two video cameras and camera pedestals at the 0 Level.[57] The most visual feature of Side 1 is the array of platforms that extend across the entire elevation (Photo No. 1). For 66'-6" from the west corner and 27' from the east corner, the platform ensemble consists of a single level, which sits 16'-6" below the top of the MLP. The west portion contains the LOX piping system valves (Photo No. 9); the east platform provides access to the fire hose connection. In between these sections is a dual-level platform. The upper platform, which is four vertical bays in length, sits 13'-6" below the top level and holds the LH2 piping system valves (Photo No. 10); the lower platform, which is five bays in length, sits 21'-6" from the top of the platform and contains an electrical panel, a pneumatic panel, and an instrumentation panel. Providing access between the single- and dual-level sections are metal steps and/or ladders. Above the west LOX section and the central LH2 area are 6'-6" to 7'-6"-deep blast shields to protect the equipment during launch.

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[55] MLP-3 was photographed for this documentation package, and will be described herein. The three MLPs are essentially identical to one another, but any differences will be addressed throughout the description, as applicable.

[56] The official names of the sides of each Mobile Launcher Platform, as designated by NASA, are "Side 1," "Side 2," "Side 3," and "Side 4;" therefore, these are the titles used throughout the description. Likewise, the official names of the three floor levels, "0 Level," "A Level," and "B Level," will be used.For the sake of clarity of this description, the MLP will be described as if it was parked at the launch pad so that these polar directions may be used, particularly for the discussion of the interior.

[57] On MLP-1, there are two video cameras each in the fourth and thirteenth bays; MLP-2 has no video cameras mounted along Side 1. RS&H, "MLP-1"; RS&H. "Modifications to convert ML No. 2 to Mobile Launcher Platform No. 2/MLP No. 2." March 1977.

Side 2, the west elevation, has a height of 25' and contains one access door to each internal level (Photo Nos. 2-4). Additional features that correlate to the A Level include three connectors for environmental control system ducts and a connector for a GN2 pipe towards the north end, and a pair of pneumatic mufflers near the south end. At the north end of the B Level, there is a series of four instrumentation interface panels; to the south are two industrial power interfaces and a receptacle for emergency power. Extending across the length of this façade and centered vertically, there are two LOX pipes with eight support brackets. In addition, Side 2 has two 8" downspouts that rise through the height of the elevation, one near the north end that resembles a backwards "4" and the other at the south end, which mimics a reversed "D".[58]

Side 3 is the simplest of the four elevations and has a height of 25' (Photo Nos. 4-6). Along this side, there is one access door near the center that leads to the B Level. Above this door and towards the east are diagonal braces at the A Level that provide additional structural support. At each end of this façade there is a diagonal brace, which extends from the lower corner to the top of the platform. Also, at each end of this side are the flanges for the LOX and the LH2 piping. Two video cameras are mounted at the 0 Level (Photo No. 23); just below the western camera is a hazardous gas detection interface.[59]

The final elevation, Side 4, is similar to Side 2 in that it is also 25' high and has a pair of pipes that are centered vertically and extend across the length of the façade (Photo Nos. 6-8). These pipes, however, have only seven support brackets and are used for LH2. Likewise, Side 4 contains one 8" downspout at each end, which resembles the downspout at the south end of Side 2. Additional features include one camera mount at the 0 Level; two access doors and two vent relief stacks at the A Level; and two access doors, one ventilation louver, and four pneumatic piping interfaces at the B Level.[60]

The bottom face of the MLP is essentially a flat surface. The three exhaust holes are visible at the Side 1 end of the platform, and the perimeter of the openings is lined with blast shields like the inner faces (Photo No. 11). The only other features on the bottom of the MLP are the four connectors for mating to the Crawlers. These are spaced 90' on center and consist of a square base, with a large "washer" and a bolt in the middle (Photo No. 12).

0 Level

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[58] On MLP-1, the only difference to this side is that the north downspout has only a vertical pipe; MLP-2 is exactly the same. RS&H, "MLP-1"; RS&H, "MLP-2".

[59] Side 3 of MLP-1 is exactly the same; however, Side 3 of MLP-2 contains an additional hatch opening within the eleventh bay at the B Level. RS&H, "MLP-1"; RS&H, "MLP-2".

[60] The only difference among the other two platforms is that MLP-1 does not have a video camera at the 0 Level. RS&H, "MLP-1"; RS&H, "MLP-2".

As previously mentioned, the top surface of the MLP is also known as the 0 Level (Figure No. 10; Photo No. 13). In plan, this level can be divided into three distinct areas: the orbiter area at the south end (along Side 1); the SRB/ET area in the middle; and the open area at the north end (along Side 3). Within the orbiter area is the 34' x 31' exhaust hole for the vehicle's SSMEs, which is centered along the east-west axis and is faced with a heat shield (Photo Nos. 14 and 15). Around the perimeter of the opening is a 5'-wide blast shield, which is mounted 1' above the platform's surface. Underneath this shield is a series of water spray nozzles that are part of the sound suppression system.[61] There are two breaks within the blast shield, which correspond to the most prominent features of the 0 Level, the TSMs.

The TSMs are positioned near the north end of the SSME exhaust hole, so that one is on the starboard side of the orbiter (east) and the other on the port side (west). The masts are mirror images of one another, with dimensions of 15' in length (east-west), 9' in width (north-south), and 31' in height. The inner face of each TSM (next to the SSME exhaust hole) features a rotating hood in the rounded top (Photo No. 17).[62] The north face of each TSM has an access ladder at the inner corner; the outer side features an access ladder and a series of pipes (Photo Nos. 16 and 17). The south face of each TSM has a door, which provides access to the interior (Photo No. 18). The interior of each TSM has piping toward the inner side (Photo No. 19), and the counterweight mechanism for the rotating hood on the outer side.

Just to the south of the SSME exhaust hole, are the exhaust holes for the two SRBs, which measure 42' x 20', and are mirrored across the central north-south axis. Like the SSME exhaust hole, these openings are faced with a heat shield (Photo Nos. 20 and 21). Within the south half of each opening, are four SRB support pedestals, each of which consists of a 7' x 5' bracket-like base with a hollow cone on top that has a height of 5' and a base diameter of 4' diameter. It is through this cone that the stud to which the SRB is actually attached travels.[63] Surrounding each SRB exhaust hole on the 0 Level is a system of overpressure water screen piping, with ducts that extend into the opening.

The north area of the platform contains a 96' x 64' blast deck; its surface is at 1'-6" above the 0 Level. The prominent features of this area of the MLP are the six large spray pipes ("rainbirds"), which are part of the sound suppression water system. Three of these are located among the north end of the SRB exhaust holes; one between the two openings and one to each outer side. The other three rainbirds are within the blast deck, one at the centerline and one to each end. All of the spray pipes have a height of 10'-6", which includes the 6'-diameter slanted hood at the top. The two center pipes have a 4' diameter; that between the two SRB openings also has two

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[61] The blast shield also supports a handrail, which is removed prior to launch. RS&H, "MLP-1"; RS&H, "MLP-2".
[62] See page -. The carrier plate, which supports the umbilical connections, has a length of 6', a width of 4', and a depth of 2' (see Photo A-4). The TSMs provide umbilical connections for the LH2 and LOX (port and starboard, respectively), gases, ground electrical power, and communications links.
[63] See pages 14 and 15.

pipe connections in the bottom portion (Photo No. 22). The other four pipes are smaller, with a diameter of only 2'-6 (Photo No. 23). Also within the blast deck are two pedestal camera mounts (Photo 24), and a 4' x 17' stairwell entranceway.

Interior

The interior of the MLP contains a total of thirty-eight rooms arranged over the A and B Levels. Eleven of these rooms extend through the full height of the platform's interior; all of which are adjacent to one of the platform's exhaust openings (Figure Nos.11 and 12).[64] Five of these rooms (32AB, 35AB, 38AB, 39AB, and 42AB) are located between the SRB exhaust holes and the SSME exhaust hole, and are primarily used to access the walls of these openings. Five of the six remaining rooms (30AB, 36AB, 40AB, 46AB, and 47AB) are located along the west, north, and east sides of the SRB openings. Three rooms, 30AB, 46AB and 47AB, are used to access the walls of the SRB openings. Room No. 36AB, between the two SRB openings, used to contain control panels, but is now empty (Photo No. 26). Room No. 40AB, west of the port SRB exhaust hole, contains sound suppression pipes. The last of the dual-height spaces, Room No. 45AB, extends along Side 1 of the MLP and contains fire suppression pipes along the north wall (Photo No. 27). It can also be used as a hallway at the B Level.

The A Level, which sits approximately 11.5' above the bottom surface of the MLP, contains fifteen additional rooms to those described above (Figure No. 11). It can be accessed directly from the 0 Level, one access door on Side 2, or one of two access doors along Side 4. The stairwell from the 0 Level opens into the only true corridor within the platform, which extends from the stairwell, west to the door on Side 2; an air lock sits at its east end and opens into the largest area of the A Level. This space extends across Side 3, includes Room Nos. 7A, 8A, 9A, and 10A, and has maximum dimensions of 89' east-west and 60' north-south. Room Nos. 8A and 9A contain power supply panels for the platform near the east wall (Photo Nos. 28 and 29), as well as its computer systems along the north wall (Photo Nos. 29 and 30). Additional electrical panels extend through Room No. 7A and into the north half of Room No. 10A (Photo No. 31). In the south half of Room No. 10A are electrical panels for the hazardous gas detection system and data panels for the orbiter payloads (Photo No. 32). A doorway in the south wall of this room leads into the corridor.

To the west of this area is Room No. 15A, which has a welded, acoustical enclosure offset from the structural frame. This room, which sits at the northwest corner, was designed to be used by the DoD for classified payloads, but is now storage space.[65] The doorway from the corridor into this room is leaded and consists of a large outer door, and a double inner door (Photo No. 33). Across the corridor from Room No. 15A is Room No. 19A, which is also used for storage; to the east of this space is Room No. 18A, a personnel restroom. To the east of Room No. 18A is Room No. 21A, which measures 43' x 13' and contains the Halon fire suppression system (Photo No.

[64] These are denoted by the letters "AB" after the room number.

[65] Raulerson.

34). Within this space, there are panels mounted on the north and south walls, and a line of panels down the center of the room. There is also a door on the west wall that leads into the above-described Room No. 9A. At the northeast corner of the MLP is Room No. 1A, which has an external access door and is used for storage.

To the south of Room No. 1A and extending for the remainder of Side 4 is Room No. 2A, with dimensions of 100' x 21' (Photo No. 35). This room contains all of the equipment necessary to provide super clean air to those spaces within the orbiter that require a "Clean Room" atmosphere. At the south end of this room is a metal staircase that provides access to the B Level. Located to the east of the SSME exhaust opening are Room Nos. 33A and 34A. Room No. 33A, to the north, has dimensions of 27'-6" x 19'. It contains the monitors for the super clean air system within Room No. 2A along the south wall, as well as pipes for the environmental control system and the sound suppression system on the north wall (Photo No. 36). Room No. 34A, to the south, measures 27'-6" x 20' and contains pneumatic panels for the orbiter's payloads along the east and south walls, and perpendicular to the north wall (Photo Nos. 37 and 38). There are also pipes for the sound suppression system along the west wall (Photo No. 39).

Adjacent to the west side of the SSME exhaust hole are Room Nos. 43A and 44A, to the north and south, respectively. Their dimensions are exactly the same as their counterparts on the east side. Room No. 43A contains panels along the north and south walls, which monitor the platform's hydraulics and hazardous gas systems (Photo No. 41). Room No. 44A has panels along the north, east, and south walls which control and monitor the ET and SSME purge tanks (Photo No. 41). Also extending through both rooms along the east wall is a pipe for the sound suppression system. Room No. 16A is a 98' x 22' space, which sits along Side 3 and contains electrical panels for the platform's power systems (Photo No. 42). These panels extend for nearly the entire length of the room within the western half. Like Room No. 2A, there is a metal staircase to the B Level at the south end. Near the halfway point of this space is a door which opens into Room No. 41A, to the east of Room No. 16A that contains winches that aid in the placement of various ground support equipment used within the MLP (Photo No. 43). Room No. 37A, which sits between the two SRB exhaust holes, also contains winches.

The internal layout of the B Level, which sits 2'-6" above the base of the MLP, is nearly identical to that of the A Level, the exceptions being that it only has twelve additional rooms aside from the dual-height spaces, and there is no corridor at the north end (Figure No. 12). At the north end of the platform are three rooms. The first of these is the large space in the center, which contains Room Nos. 7B, 8B, 9B, 10B, 21B, and 22B and has overall dimensions of 89' x 60'. In the middle of the room is the stairwell that extends up to the 0 Level and an air lock in the center (Photo Nos. 44 and 45). Scattered throughout the room are various instrumentation panels, ground measurement system (GMS) panels (Photo No. 46), and a large pipe that is part of the sound suppression system (Photo No. 47). To the east of this area is Room No. 1B, which contains pneumatic panels for the GHe and GN2 systems (Photo No. 48); to the west is Room No. 15B that holds all of the instrumentation panels and interfaces for the orbiter (Photo No. 49).

The layout of the remainder of the B Level is identical to that of the A Level, with identical room numbers, although the letter is changed, i.e., Room No. 2B is directly underneath Room No. 2A or Room No. 33B is directly underneath Room No. 33A. Additionally, all of the B Level rooms are the exact same size as their A Level counterparts; the only difference lies in the equipment contained within the B Level rooms. Room Nos. 2B and 16B contain all of the hydraulic systems for the starboard and port SRBs, respectively. This equipment is spaced throughout each room and includes monitor panels, control panels, and control valves (Photo Nos. 50-52). Additionally, in Room No. 2B, there is a large pipe for the sound suppression system at each end (Photo No. 53); and Room No. 16B contains a large HVAC duct that extends for most of the length of the room (Photo No. 50).

As with the A Level, there are two rooms on either side of the SSME exhaust hole at the B Level, Room Nos. 33B and 34B to the east and Room Nos. 43B and 44B to the west. Room No. 33B contains panels on the north side of the room, which monitor the SRB purge and the ET disconnect purge (Photo No. 54); Room No. 34B contains panels on the south and west walls, as well as perpendicular to the east wall, which monitor and control the LH2 system and the cryogenics system (Photo No. 55). The LOX system is monitored and controlled on the other side in Room No. 44B, which has panels located throughout the space (Photo No. 56). Room No. 43B contains the hydraulics for the orbiter (Photo No. 57). The last room on the B Level with equipment is Room No. 41B, which is located near the midpoint of Room No. 16B, underneath Room No. 41A. On the west wall of this space are the valves for the sound suppression system (Photo No. 58).

Support Pedestals

At the maintenance site, within the VAB, and at the launch pad, the MLP is supported by six pedestals, which are stationary to their designated location. Regardless of the location, all of the pedestals are numbered in the same fashion to correspond to a specific point on the MLP. Each support is 22' in height and is bolted to a concrete base. Among the six posts, there are three distinct styles. The first is a simple vertical column, which is used for Pedestal Nos. 3, 4, and 6; they are located at the southeast, northwest, and southwest corners, respectively (Photo No. 59). The second style of support post consists of a vertical column with a diagonal brace from the top of the column to a concrete base. This is used for Pedestal No. 1, which sits at the northeast corner (Photo No. 60), and Pedestal No. 5, which sits along Side 2. For the former, the brace extends out to the east; for the latter, it extends to the north. The final style, used only for Pedestal No. 2 along Side 4 (Photo No. 61), is a vertical column with two diagonal braces; one that extends from the top of the column out to the east and one that extends down to the north.

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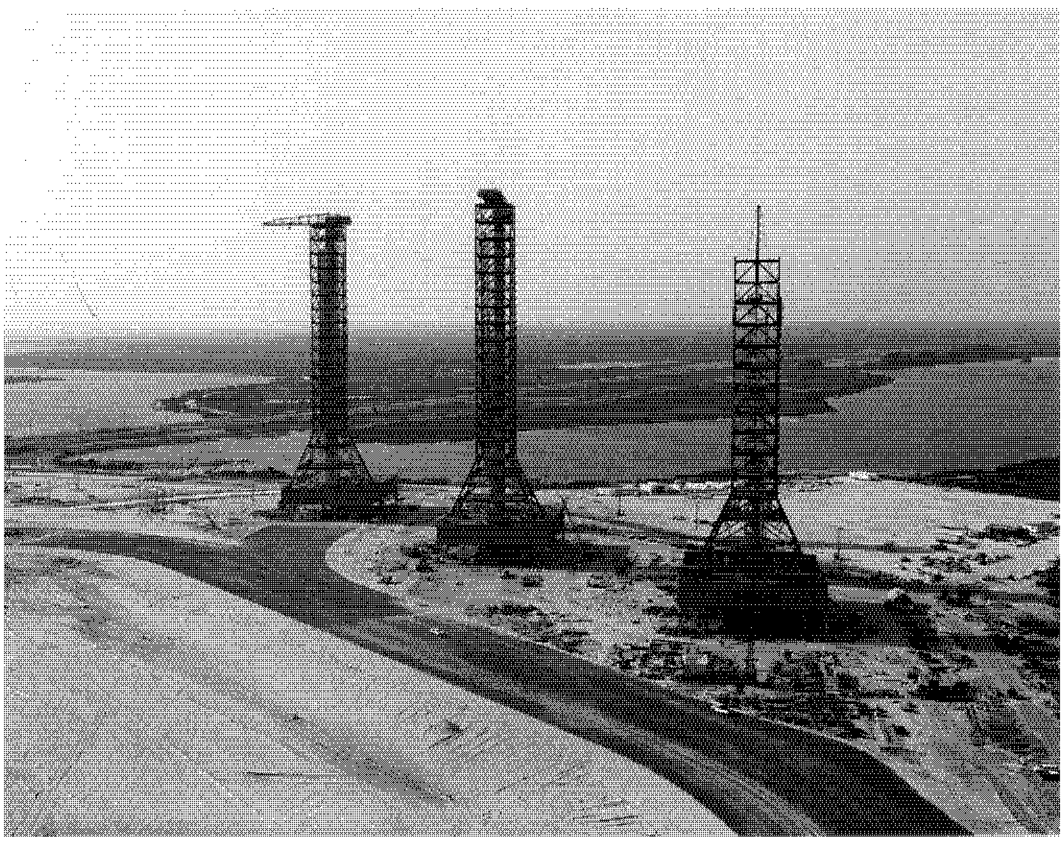

Figure A-1. Construction of mobile launchers, January 18, 1965.
Source: John F. Kennedy Space Center, KSC-64C-3716, accessed via NASA Image Exchange (NIX) at http://nix.nasa.gov/.

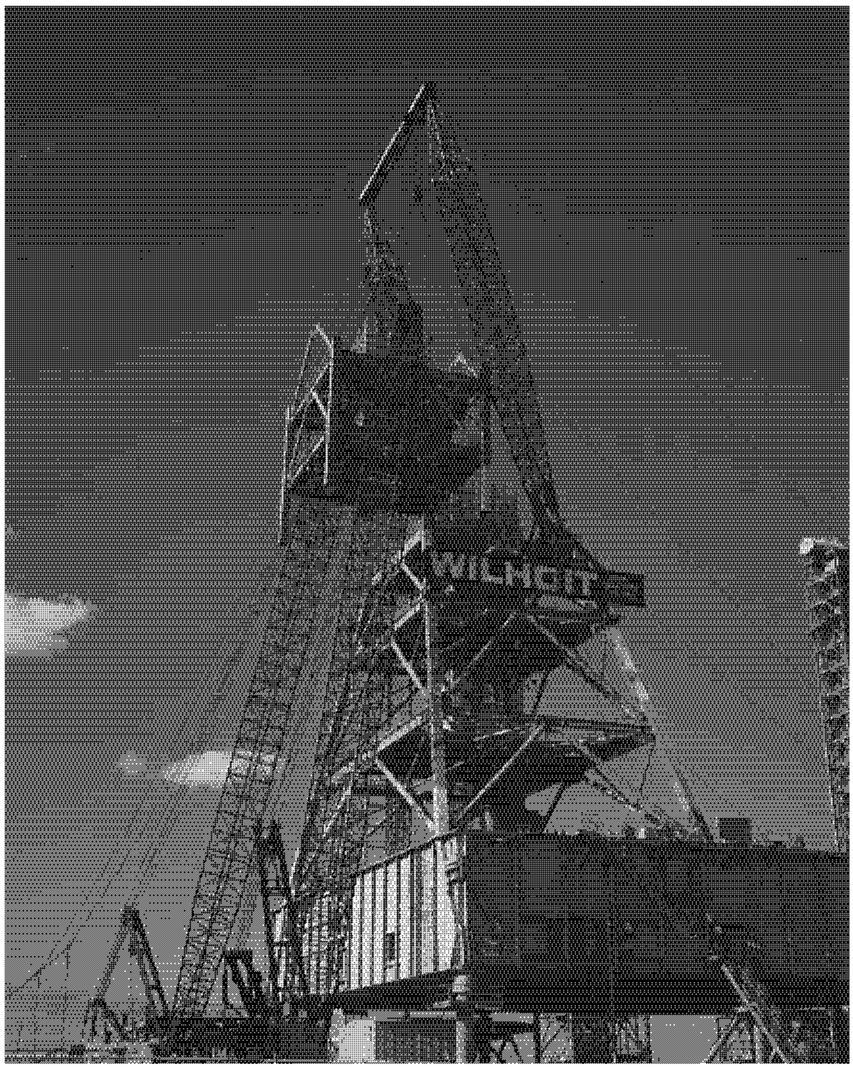

Figure A-2. Removal of the LUT from ML-3, March 2, 1976.
Source: John F. Kennedy Space Center, KSC-76C-0715, accessed via NIX at http://nix.nasa.gov/.

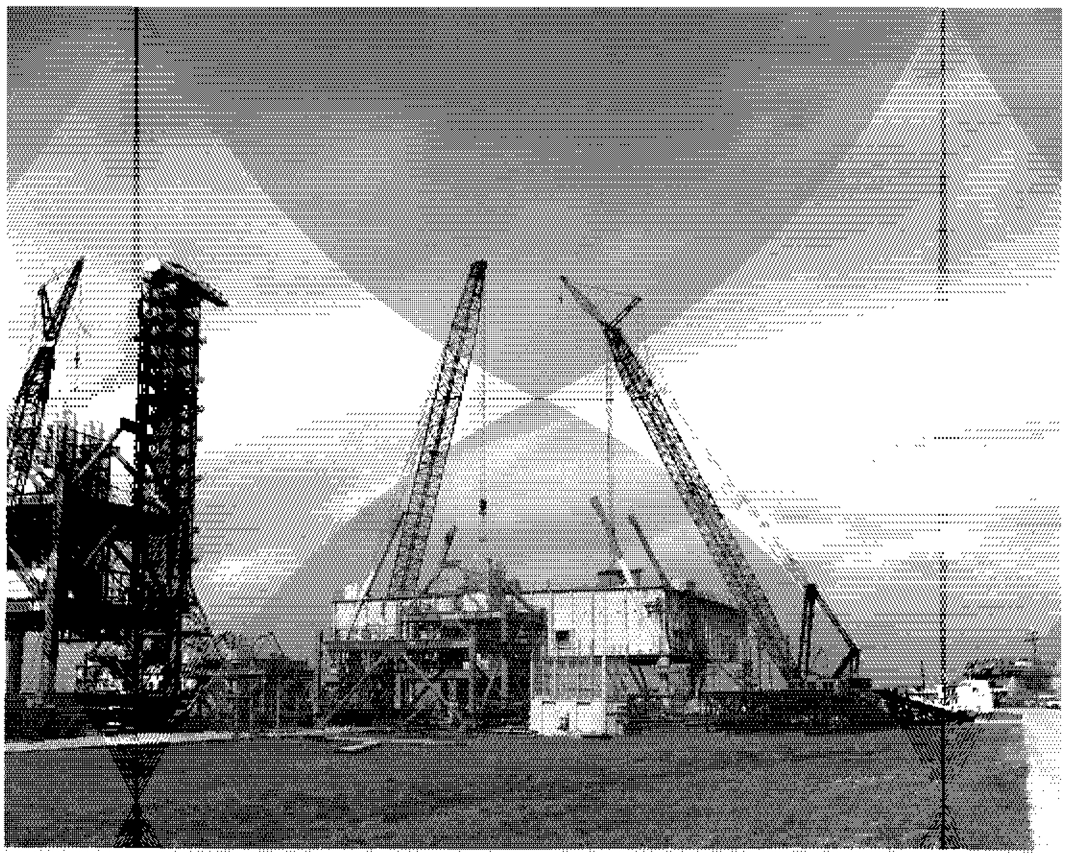

Figure A-3. Mobile Launcher No. 3 after removal of tower during modifications to become Mobile Launcher Platform No. 1, March 22, 1976.
Source: John F. Kennedy Space Center, KSC-76C-0904, accessed via NIX at http://nix.nasa.gov.

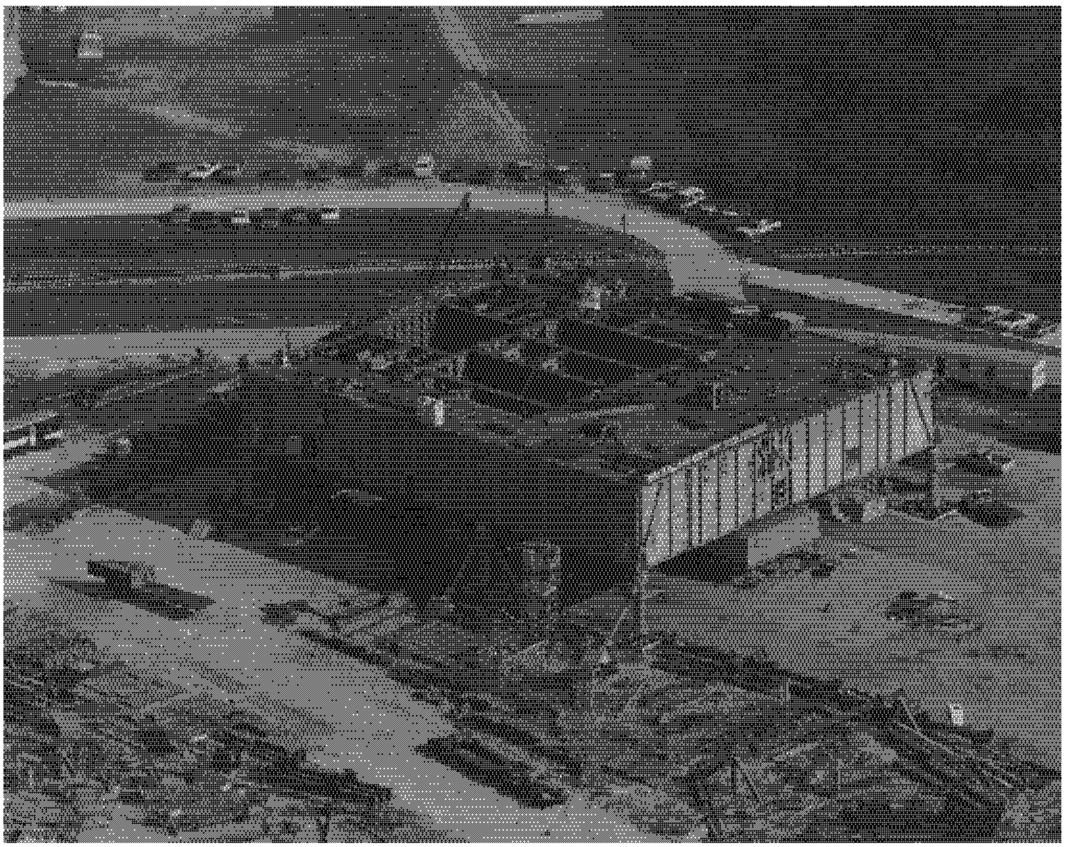

Figure A-4. Construction of Mobile Launcher Platform No. 1, September 24, 1976.
Source: John F. Kennedy Space Center, KSC-76C-2754, accessed via NIX at http://nix.nasa.gov.

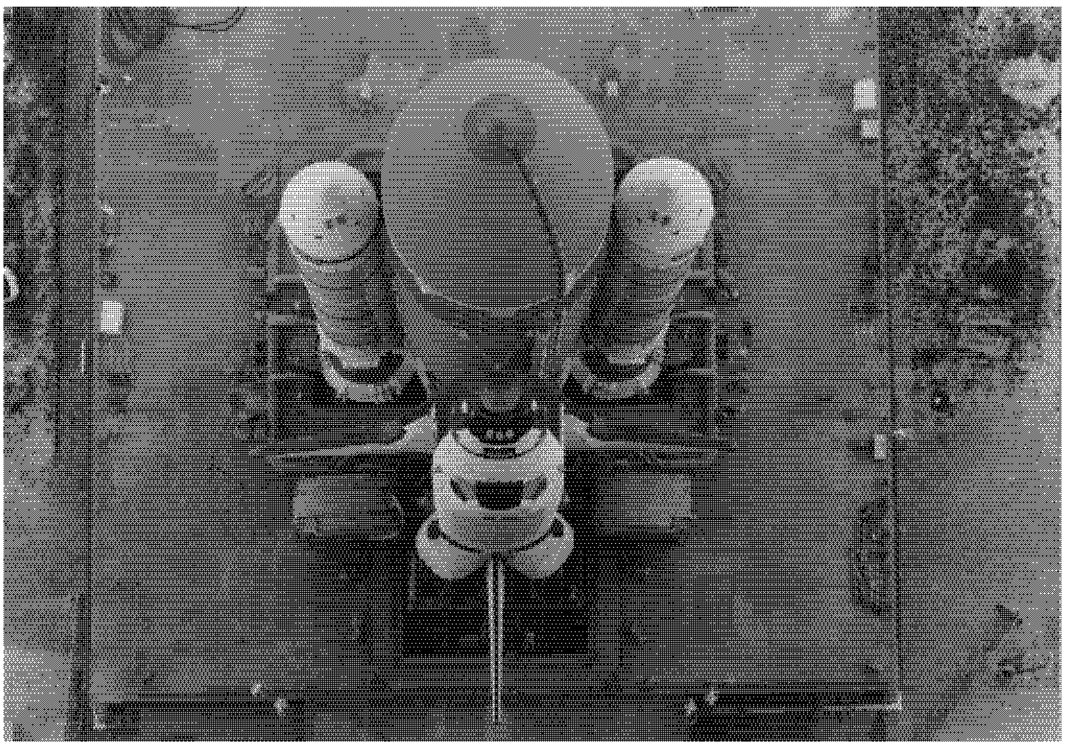

Figure A-5. Bird's eye view of Space Shuttle *Atlantis* on Mobile Launcher Platform, August 20, 1996.
Source: John F. Kennedy Space Center, KSC-96PC-0997, accessed via NIX at http://nix.nasa.gov/.

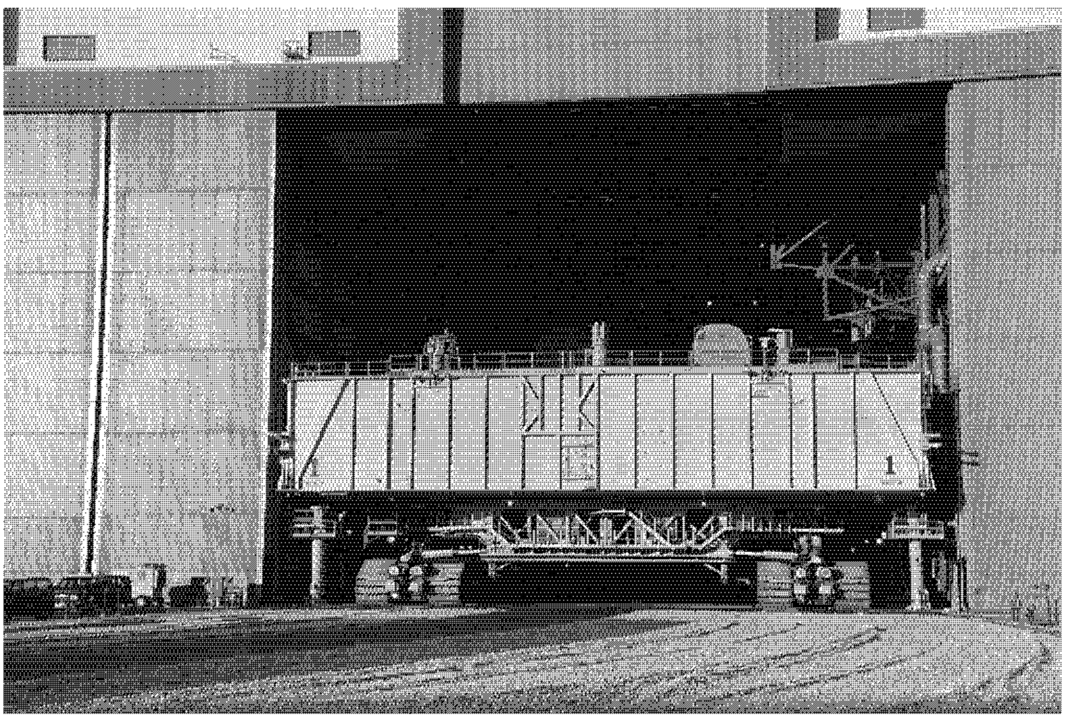

Figure A-6. Mobile Launcher Platform No. 1 in VAB High Bay No. 2, June 1, 2000.
Source: John F. Kennedy Space Center, KSC-00PP-0723, accessed via NIX at
http://nix.nasa.gov/.

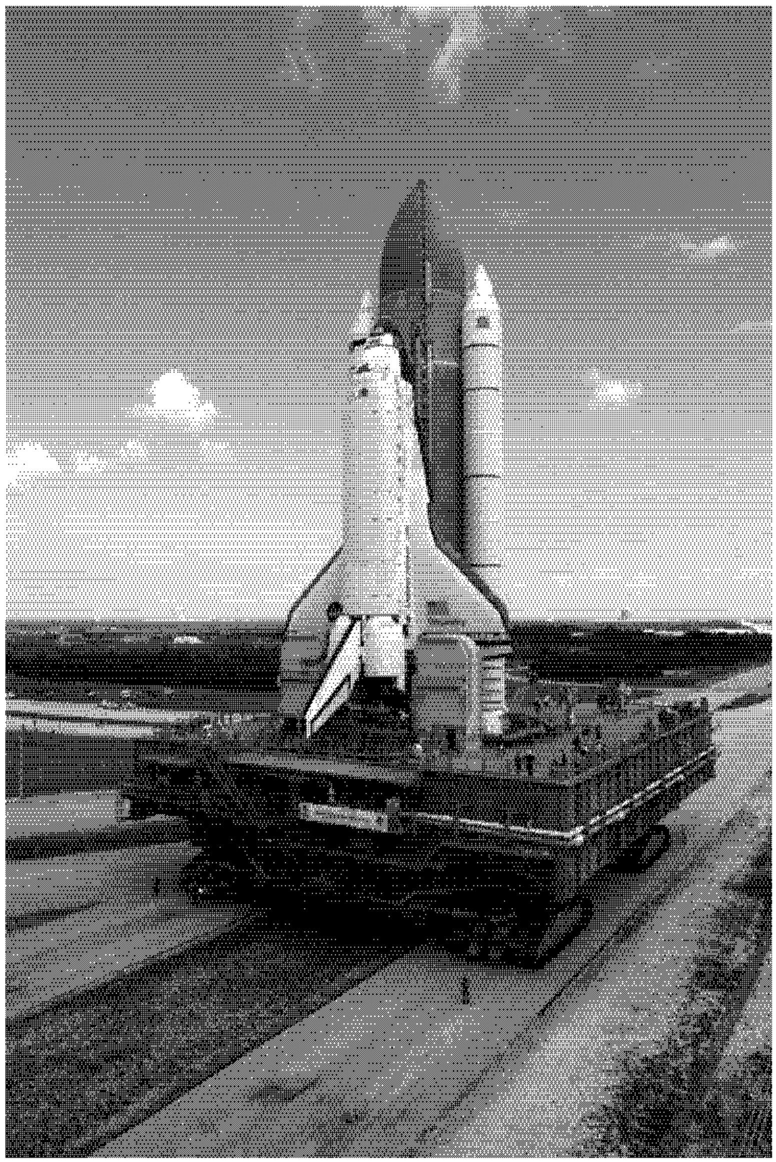

Figure A-7. Crawler Transporter carrying Mobile Launcher Platform with Space Shuttle *Discovery* to Launch Pad 39B, April 6, 2005.
Source: John F. Kennedy Space Center, KSC-05PD-0600, accessed via NIX at http://nix.nasa.gov/.

Figure A-8. Water sound suppression test at launch pad, note water coming out of spray pipes, May 7, 2004.
Source: John F. Kennedy Space Center, KSC-04PD-1064, accessed via NIX at http://nix.nasa.gov/.

Figure A-9. Workers disconnect electrical and communications fittings between Mobile Launcher Platform and launch pad, May 7, 2004.
Source: John F. Kennedy Space Center, KSC-05PD-1135, accessed via NIX at http://nix.nasa.gov/.

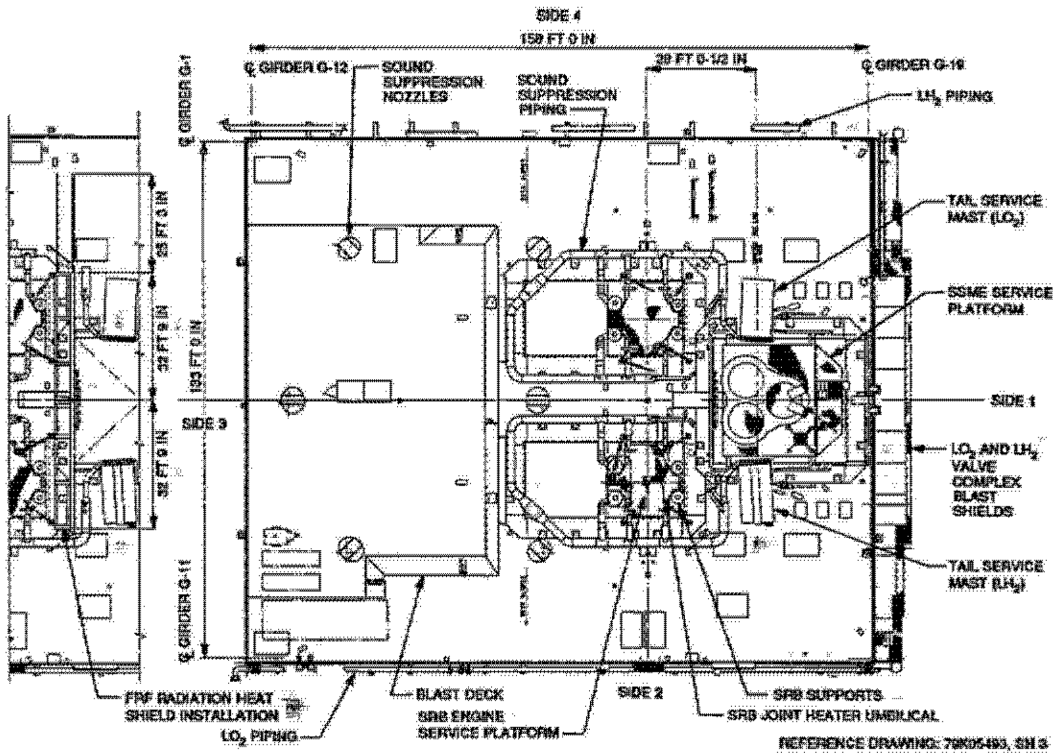

Figure 10. Diagram of the MLP's 0 Level.
Source: NASA KSC. *Space Shuttle Launch Support Equipment Data Handbook,* March 30, 1993.

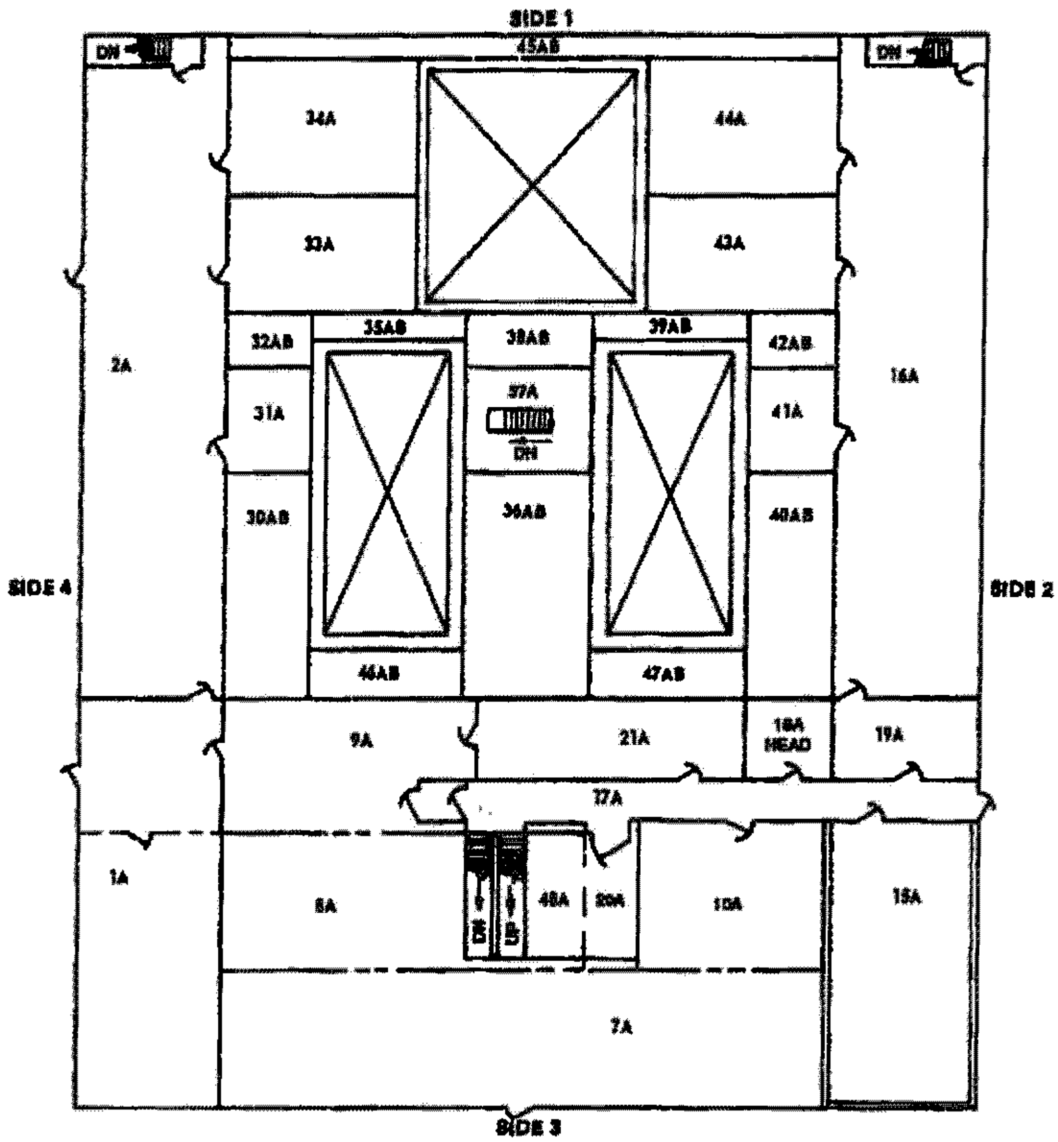

Figure 11. Diagram of the MLP's A Level.
Source: NASA KSC. *Space Shuttle Launch Support Equipment Data Handbook,* March 30, 1993.

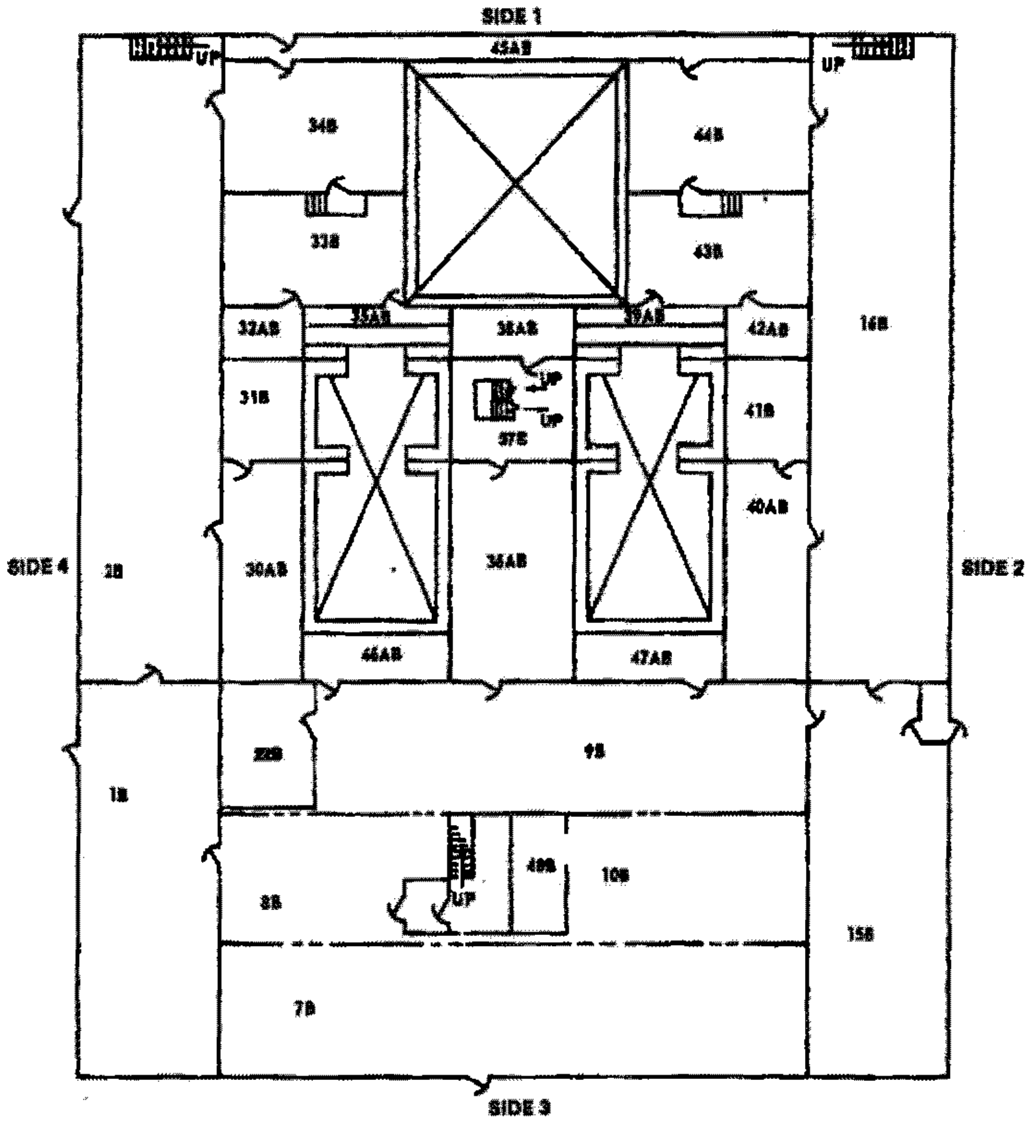

Figure 12. Diagram of the MLP's B Level.
Source: NASA KSC. *Space Shuttle Launch Support Equipment Data Handbook,* March 30, 1993.